Proc. NIPR Symp. Antarct. Geosci., 8, 160–168, 1995

^{40}Ar-^{39}Ar GEOCHRONOLOGICAL STUDIES OF GRANITIC ROCKS FROM SOUTH VICTORIA LAND, ANTARCTICA

Yutaka TAKIGAMI[1] and Teruo WATANABE[2]*

[1]*Kanto Gakuen University, Fujiagu 200, Ohta 373*
[2]*Deptartment of Applied Geology, University of Technology, Sydney, NSW 2007, Australia**

Abstract: ^{40}Ar-^{39}Ar ages were obtained for two granitic rocks from the Dry Valleys region of South Victoria Land, Antarctica. One sample (biotite-rich fraction) of foliated granitoid gave three age increments of 491 Ma, 502 Ma and 506 Ma, with K/Ca ratios suggesting influence of cooling ages of biotite (younger age) and that of hornblende (older age). Granitoid emplacement is thought to have been before 506 Ma, with cooling from biotite closure temperatures about 490 Ma. A sample of unfoliated granitoid gave ages of 467–496 Ma. The similarity of ages determined for both "pre-tectonic" and "post-tectonic" samples indicate closure of isotopic systems around 490 Ma due to regional uplift/exhumation, rather than actual emplacement ages of individual plutons in South Victoria Land.

1. Introduction

South Victoria Land lies on the eastern margin of East Antarctica facing the Ross Sea (Fig. 1). Geochronological studies reveal that Ross Orogeny plutonism and metamorphism of basement rocks occurred within a time-span from 600 Ma to 450 Ma. The majority of ages have been determined by Rb-Sr and K-Ar techniques, with many ages determined at about 490 Ma (ALLIBONE *et al.*, 1993a). Detailed mapping indicates that a significant change in both the intrusive style and chemistry of granitoids occurred at this time, which is thought to reflect a major change in the tectonic setting Antarctic Craton margin (ALLIBONE *et al.*, 1993a, b). However, it has not yet to be established whether the Rb-Sr and K-Ar ages truly represent the emplacement and cooling of individual plutons, with significant pulse of magmatism and change in tectonic setting at about 490 Ma, or whether these ages represent the regional closure of Rb-Sr and K-Ar systems during uplift and cooling.

In this paper we present results from an ^{40}Ar-^{39}Ar study of two samples from South Victoria Land: a foliated "pretectonic" orthogneiss, and an unfoliated "post-tectonic" granite. The purpose of the study is to determine ages using ^{40}Ar-^{39}Ar techniques, and to see whether or not the ^{40}Ar-^{39}Ar spectra can discriminate different thermal histories that may relate to emplacement ages, or whether they record a similar regional uplift and closure of isotopic systems. These preliminary results are part of a detailed study of the thermal

*On leave from Department of Earth and Planetary Sciences, Graduate School of Science, Hokkaido University, Kita-10, Nishi-8, Kita-ku, Sapporo 060.

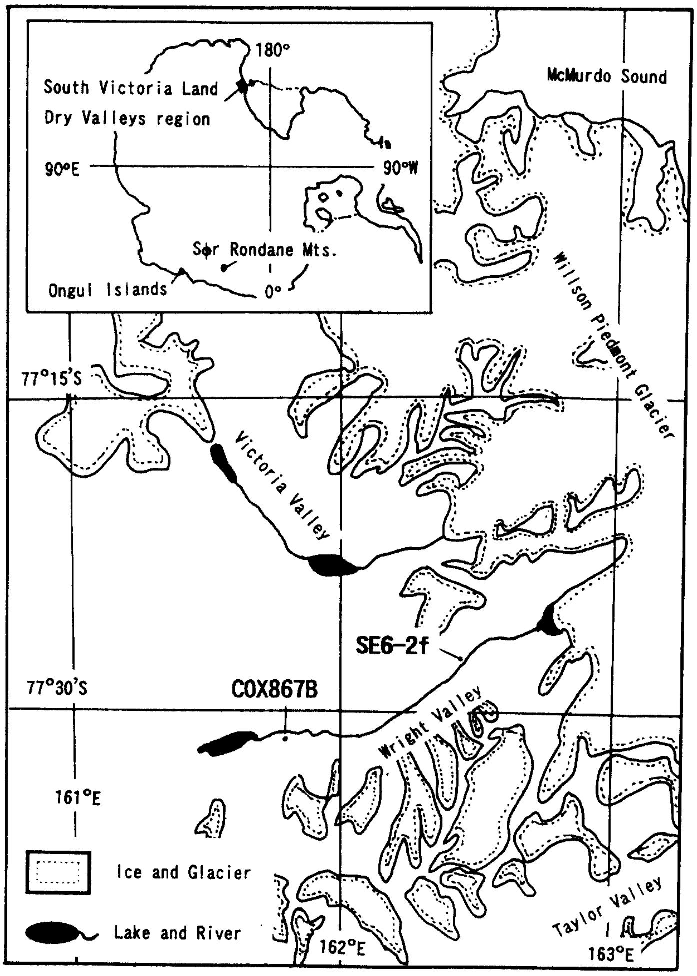

Fig. 1. Dry Valleys region in the South Victoria Land and sampling localities (modified after ALLIBONE *et al., 1993a).*

and intrusive history of granitoids in South Victoria Land.

2. Regional Geology

The oldest rocks of southern Victoria Land are multiply deformed, upper amphibolite facies Koettlitz Group metasediments (GUNN and WARREN, 1962; GRINDLEY and WARREN, 1964; FINDLAY *et al.*, 1984; ALLIBONE, 1992), of possible late-Proterozoic age (ADAMS and WHITLA, 1991). At least two phases of deformation have affected Koettlitz Group metasediments during the Ross Orogeny. During the later stages of deformation, Koettlitz Group metasediments were intruded by granitoids of the Granite Harbour Intrusives (GRINDLEY and WARREN, 1964; COX, 1993).

On the basis of field relations and geochemistry, granitoids in the Dry Valleys region of South Victoria Land were subdivided into three petrogenetically distinct suites (ALLIBONE *et al.*, 1993a, b). The DVla (Dry Valley la) suite consists of Cordilleran I-type granitoids including the batholithic-scale Bonney Pluton and at least four other major plutons of hornblende-biotite granitoid, and hornblende-biotite orthogneisses (COX and

ALLIBONE, 1991). The DV1b suite comprises several large plutons of biotite granodiorite and granite, and younger plugs of biotite granite, as well as biotite orthogneisses. Both the DV1a and DV1b suites were time transgressive, and emplacement of older orthogneisses in each suite overlapped. Field relationships and limited Rb/Sr dating indicate plutonism before about 500 Ma was dominated by the DV1a suite, which predated a major pulse of DV1b plutons with Rb/Sr ages all around 490 Ma. Overlapping plutonism has resulted in complicated mutually crosscutting relationships between granitoids of the DV1a and DV1b suites. Younger DV2 alkali-calcic, Caledonian I-type plutonism is inferred to have formed in response to uplift and extension between about 486 Ma and 455 Ma. K-Ar dating of granitoids yields a range of uplift ages, mostly 480–420 Ma (ANGINO *et al.*, 1962; JONES and FAURE, 1967; FAURE and JONES, 1974; MCDOUGALL and GHENT, 1970). Isotopic dates from Antarctica were compiled by STUVIER and BRAZIUNAS (1985).

Emplacement of granitoids was followed by uplift and erosion of the regionally extensive Kukri Erosion Surface. Deposition of the Devonian to Triassic Beacon Supergroup followed, consisting primarily of texturally mature sandstones, siltstones, and minor coal measures, with a total thickness of about 2 km (BARRETT *et al.*, 1986). Sills and dykes of tholeiitic Ferrar Dolerite intruded all of the above rocks during the Jurassic (KYLE *et al.*, 1981). There is little evidence of geological activity until development of the Royal Society Range (part of the Transantarctic Mountains) during rifting in the Ross Sea in the middle Cenozoic (GLEADOW and FITZGERALD, 1987). Apatite fission track ages from Wright Valley granitoids vary from 66–154 Ma with altitude, recording the period since uplift from tempertaures about 100–125°C (GLEADOW *et al.*, 1984). Sparse but widespread veins cut both basement and overlying sediments, and are thought to result in part from hydrothermal activity associated with both Ferrar Dolerite intrusion, and later uplift (CRAW and FINDLAY, 1984; CRAW *et al.*, 1992). The youngest rocks of the Dry Valleys region are Miocene-Recent moraines and small alkali basanite flows and scoria cones of the McMurdo Volcanics.

3. Samples

Two samples of hornblende-biotite granitoids with contrasting lithofacies were selected for ^{40}Ar-^{39}Ar dating. The samples are from Wright Valley, with one sample (SE6-2f) from an outcrop of orthogneiss (162°5.6′E, 77°7.1′S) and the other (COX867B) from an undeformed granitic dyke (161°2.5′E, 77°1.8′S) (Fig. 1). Biotite-rich fractions were separated from each sample by isodynamic separator for analysis. Although coarse grained hornblende was separated from the analysed samples, some of fine grained hornblende included in the biotite aggregates was not successfully separated. Preparation of very fine grained biotite sample (less than 200 mesh) is required for a further precise dating study.

Sample SE6-2f was collected by Mr. S. ELLERY from the Mt. Theseus area, Lower Wright Valley (ELLERY, 1989). The sample has a weak foliation represented by hornblende-biotite alignment, which is parallel to foliation in the highly deformed Koettlitz Group metasediments it intrudes. The sample is composed of potassium feldspar, plagioclase, quartz, biotite and hornblende as main constituent minerals. Granular subgrain texture in quartz suggests recrystallization and amalgamation of pre-existing finer grained quartz as a result of deformation.

Sample COX867B was collected by Dr. S.C. Cox near Lake Bull in Wright Valley, from a leucocratic granitic dyke lying within the Bonney Pluton (ALLIBONE *et al*., 1993a). The sample is massive and unfoliated, with biotite, potassium feldspar, plagioaclase and quartz as the main constituent minerals. Hornblende and titanite are minor constituents, and are typically associated with in biotite aggregates. Some biotite in the sample shows minor oxidation.

4. Experiments

Biotite-rich fractions of two samples were wrapped in Al foils and sealed in a quartz tube (70 mm$\times$10 mm ϕ) in vaccum condition. JG1-biotite (biotite separated from JG-1 standard sample of granite by the Japan Geological Survey, K_2O=7.64$\pm$0.05 wt%, Age=90.8$\pm$1.7 Ma), were sealed together with K_2SO_4 and CaF_2 as the age standard and collection standards of K- and Ca-derived interference Ar isotopes, respectively. The quartz tube was wrapped in Cd foil in order to decrease the thermal neutrons in the reactor. They were irradiated with fast neutrons for 24 hours in Japan Material Testing Reactor, receiving about 10^{18} total neutrons.

After about 8 months, Ar gas was extracted from the each irradiated sample in a Mo crucible using an induction heater at Radio Isotope Center, University of Tokyo. Temperature of the top of Mo crucible was controlled by the output power of the induction heater with the aid of an optical pyrometer. Temperature was increased stepwisely for every 60 min.

Ar gas was purified by heated Ti and introduced to the Quadrupole Mass Spectrometer (MSQ-400; ULVAC Corp.) for isotopic analysis. Data were corrected for mass discrimination and are listed in Table 1. Ages were calculated from ratios of radiogenic ^{40}Ar over K-derived ^{39}Ar using the age standard data of JG-1 biotite after further correction of K- and Ca-derived interference isotopes. Calculated ages are also listed in Table 1.

5. Results and Discussion

Results are shown in Table 1, Fig. 2a and Fig. 2b.

Sample SE6-2f: Age spectrum of this sample shows slight increase stair type. Ages of about 488–513 Ma for each step are similar to Rb-Sr ages determined for the pulse of DV1b plutons at 490 Ma (ALLIBONE *et al*., 1993a). However, until petrochemical data is available, we prefer not to assign the sample to either of the synkinematic DV1a or DV1b granitoid suites of ALLIBONE *et al*. (1993b).

The results are separated to three parts from ages and K/Ca ratios (Table 1 and Fig. 2a) as follows;

1) 800–920°C fractions; released ^{39}Ar=38.4%; 491.2$\pm$6.5 Ma; K/Ca=70–94,
2) 980–1100°C fractions; released ^{39}Ar=12.2%; 502.0$\pm$6.6 Ma; K/Ca=15–18,
3) 1200–1500°C fractions; released ^{39}Ar=43.9%; 506.0$\pm$7.6 Ma; K/Ca=2.5.

Microsope observations and high K/Ca values indicate that the 800–920°C fractions

Table 1. Analytical data of ^{40}Ar-^{39}Ar age results.
Sample SE6-2f (biotite-rich fraction; 193.4 mg) $J=0.003091\pm0.000066^{(1)}$

Step No.	Temperature (°C)	^{40}Ar ($\times10^{-6}$ cm^3/g)	$^{36}Ar/^{40}Ar^{(2)}$ ($\times10^{-5}$)	$^{37}Ar/^{40}Ar^{(2)}$ ($\times10^{-3}$)	$^{39}Ar/^{40}Ar^{(2)}$ ($\times10^{-2}$)	^{39}Ar (%)	$^{40}Ar^*/^{39}Ar_K^{(3)}$	Age$^{(3)}$ (Ma)	K/Ca$^{(3)}$
1	600	0.196	75.46 ±3.52	3.480 ±0.292	2.433 ±0.047	2.0	31.94 ±0.75	169.8 ± 5.1	6.99 ±0.60
2	700	0.791	10.76 ±0.63	0.2577 ±0.0413	1.045 ±0.016	3.5	92.56 ±1.43	453.9 ±10.5	40.6 ±6.5
3	800	4.60	2.686 ±0.174	0.1039 ±0.0088	0.9806 ±0.0080	19.4	101.1 ±0.8	490.8 ± 9.8	94.4 ±8.0
4	860	3.18	0.5856 ±0.2092	0.1156 ±0.0134	0.9811 ±0.0137	13.4	101.7 ±1.5	493.2 ±10.9	84.9 ±9.9
5	920	1.31	1.608 ±0.265	0.1409 ±0.0209	0.9907 ±0.0118	5.6	100.4 ±1.2	487.8 ±10.4	70.3 ±10.5
6	980	0.817	0.8472 ±0.4858	0.5304 ±0.0410	0.9721 ±0.0171	3.4	102.6 ±1.8	497.0 ±12.0	18.3 ±1.5
7	1040	0.827	5.910 ±0.798	0.6326 ±0.0975	0.9303 ±0.0156	3.3	105.6 ±1.8	509.6 ±12.0	14.7 ±2.3
8	1100	1.33	2.382 ±0.270	0.6179 ±0.0409	0.9599 ±0.0105	5.5	103.4 ±1.1	500.5 ±10.4	15.5 ±1.0
9	1200	6.60	1.849 ±0.123	3.755 ±0.090	0.9364 ±0.0106	26.5	106.3 ±1.2	512.7 ±10.7	2.49 ±0.07
10	1500	4.21	5.701 ±0.401	3.882 ±0.441	0.9619 ±0.0086	17.4	102.3 ±0.9	495.8 ±10.0	2.48 ±0.28
Total		23.86	1.236	1.903	0.9871	100.0	100.3	487.1	

reference age (800~ 920°C; released ^{39}Ar 38.4%) 491.2±6.5 Ma
(980~1100°C; released ^{39}Ar 12.2%) 502.0±6.6 Ma
(1200~1500°C; released ^{39}Ar 43.9%) 506.0±7.6 Ma

are biotite, whereas the lower K/Ca fractions contain both biotite and minor hornblende. Thus, 491.2±6.5 Ma may indicate an exhumation of the granitic rocks from a level at temperatures less than the closure temperature of biotite (approximately 300°C). Exhumation from levels at the hornblende closure temperature (approximately 500°C, see FAURE, 1986) is considered to be older than 506 Ma.

Sample COX867B: Age spectrum also shows a slight increase stair type spectrum. Young ages of temperature fractions less than 760°C may be due to minor biotite alteration (oxidation). Fractions at temperature above 840°C give 467–496 Ma. Though these ages are considered to come from mainly Ar in biotite from the microscope observation, the effect of hornblende contamination should be examined carefully in future.

6. Conclusions

A granitic rock containing a weak foliation developed during metamorphism and deformation of the Ross Orogeny, sample SE6-2f, was dated by ^{40}Ar-^{39}Ar technique. A biotite-rich separate records a low temperature age about 490 Ma, whereas higher temperature fractions record ages up to 506 Ma. K/Ca ratios suggest higher temperature fractions have a greater component of Ar derived from hornblende. The data suggest exhumation of the sample occurred about 490 Ma from temperatures above biotite closure (about

Table 1. (Continued).

Sample COX867B (biotite-rich fraction; 181.0 mg) $J=0.003416\pm0.000074$

Step No.	Temperature (°C)	^{40}Ar ($\times10^{-7}$cm^3/g)	^{36}Ar/^{40}Ar ($\times10^{-4}$)	^{37}Ar/^{40}Ar[4] ($\times10^{-3}$)	^{39}Ar/^{40}Ar ($\times10^{-2}$)	^{39}Ar (%)	^{40}Ar*/^{39}Ar$_K$	Age (Ma)	K/Ca[4]
1	500	0.303	30.22	5.361	0.3463	0.6	31.39	183.8	0.64
			±0.68	±5.230	±0.0051		±5.85	±32.8	±0.63
2	600	0.442	17.14	14.46	2.886	1.6	17.23	103.2	2.0
			±1.07	±10.89	±0.056		±1.15	±7.0	±1.5
3	680	2.24	12.41	2.535	1.310	2.9	48.38	275.9	5.2
			±0.36	±4.031	±0.013		±0.95	±7.5	±8.2
4	760	4.65	6.513	0.094	0.9619	3.5	83.93	454.8	100
			±0.251	±2.235	±0.0148		±1.50	±11.3	±2400
5	840	24.9	1.137	0.3083	1.116	18.2	86.58	467.4	36
			±0.033	±0.3915	±0.010		±0.76	±9.6	±46
6	920	23.2	0.2722	1.908	1.134	16.8	87.50	471.8	140
			±0.0243	±0.534	±0.009		±0.70	±9.6	±1.7
7	1000	11.0	0.4449	0.075	1.065	7.5	92.62	496.0	140
			±0.0707	±1.562	±0.016		±1.42	±11.5	±2900
8	1100	28.3	0.4200	2.721	1.110	20.2	89.03	479.1	4.1
			±0.0300	±0.653	±0.013		±1.60	±10.4	±1.0
9	1200	37.4	0.2524	6.462	1.089	25.9	91.40	490.2	1.7
			±0.0264	±0.585	±0.009		±0.74	±9.9	±0.2
10	1500	3.85	1.755	24.94	1.101	2.8	87.30	470.9	0.44
			±0.295	±3.63	±0.019		±1.85	±12.6	±0.06
Total		141.1	1.236	3.538	1.114	100.0	86.79	468.5	

± in values are errors of one standard deviation.

(1) $J=(\exp(\lambda\cdot t_s)-1)(^{40}\mathrm{Ar}^*/^{39}\mathrm{Ar}_K)_{\mathrm{standard}}$; $t_s=90.8\pm1.7$ Ma.

(2) The correction of the K- and Ca-derived interference Ar isotopes is not taken to these values.

(3) ^{40}Ar*; radiogenic ^{40}Ar, ^{39}Ar$_K$; K-derived ^{39}Ar due to neutron irradiation.
Age $=\ln\left((^{40}\mathrm{Ar}^*/^{39}\mathrm{Ar}_k)\cdot J+1\right)/\lambda$, $\lambda=5.543\times10^{-10}$/y (Steiger and Jäger, 1977).
The uncertainties in ^{40}Ar*/^{39}Ar$_K$, ages and K/Ca do not include those of correction factors for K- and Ca-derived interference isotopes. Correction factors are as follows; $(^{40}\mathrm{Ar}/^{39}\mathrm{Ar})_K=0.03$, $(^{39}\mathrm{Ar}/^{37}\mathrm{Ar})_{Ca}=0.002496$, $(^{36}\mathrm{Ar}/^{37}\mathrm{Ar})_{Ca}=0.00005156$.

(4) Large uncertainties of ^{37}Ar/^{40}Ar and K/Ca for sample COX867B depend on the problem of mass spectrometer by measuring small amount of ^{37}Ar.

300°C), and intrusion of the granitoid before 506 Ma.

A sample of massive unfoliated granite, COX867B, has textural and field relations indicating emplacement after the bulk of deformation occurred in South Victoria Land. Biotite-rich separate from this sample gives ages of 467–496 Ma. The ages are also thought to relate to exhumation of the basement rocks.

Our preliminary ^{40}Ar-^{39}Ar study has shown that both "syntectonic" and "post-tectonic" granitoids in South Victoria Land record overlapping ages around 490 Ma. Cooling below the biotite Ar closure temperature appears to have occurred in relation to regional uplift at this time. It suggests that previous interpretations of Rb/Sr ages, which cluster around 490 Ma, probably also represent exhumation and closure of isotopic systems at 490 Ma, rather than a pulse of plutonism (Allibone *et al.*, 1993a, b). The study outlines the potential in using ^{40}Ar-^{39}Ar spectra to outline differences in the exhumation/thermal history of granitoids in South Victoria Land. Investigations are currently underway to determine whether different thermal histories can be observed between different

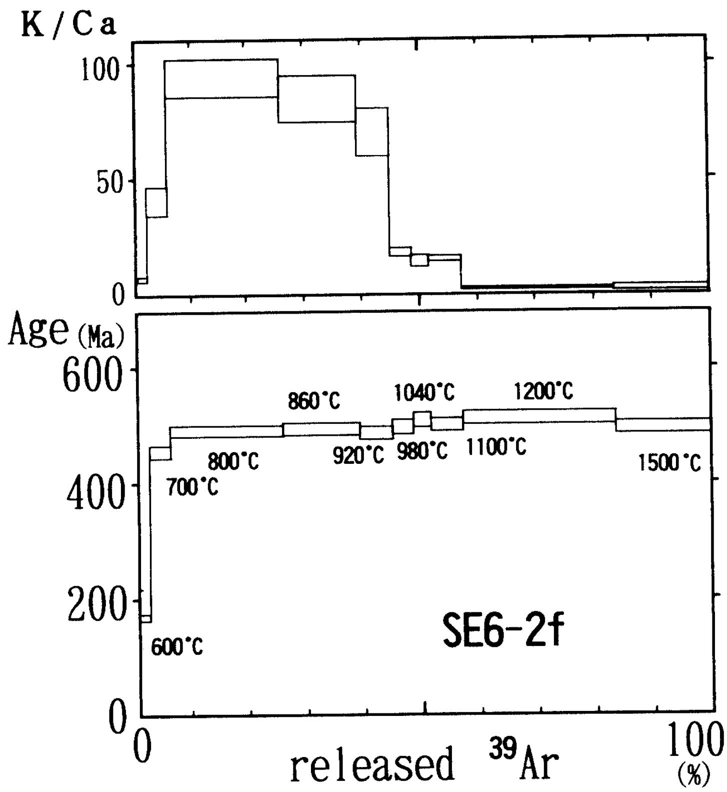

Fig. 2a. *^{40}Ar-^{39}Ar age spectrum (lower) and K/Ca (upper) for sample SE6-2f. Vertical and horizontal axes indicate the apparent age and K/Ca ratio and the released ^{39}Ar (%). The bands in the figures represent errors of one standard deviation.*
600°C, 700°C, ... indicate temperatures of the Mo crucible at the Ar gas extraction.

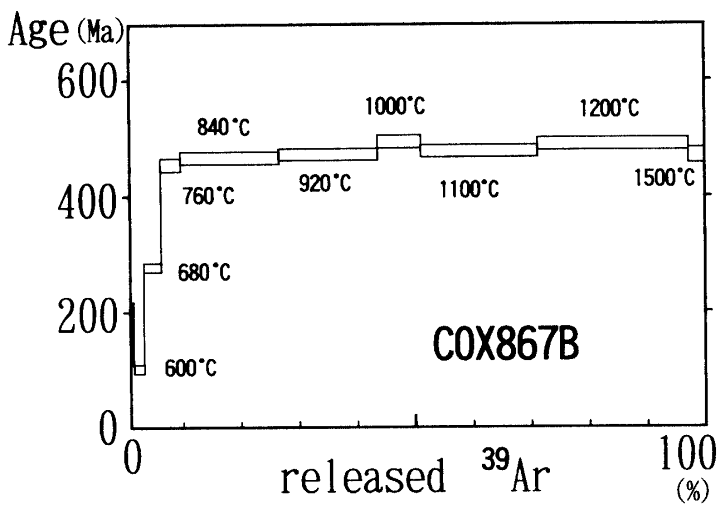

Fig. 2b. *^{40}Ar-^{39}Ar age spectrum for sample COX867B. K/Ca plot is not illustrated due to the large uncertainties.*

petrogenetic suites of the Dry Valleys region.

Acknowledgments

We wish to thank Prof. K. SHIRAISHI, National Institute of Polar Research, for giving the opportunity to submit this paper to the proceedings. We are also grateful to Dr. S. COX and Mr. S. ELLERY, Department of Geology, Otago University, for providing samples.

We were supported by the Ministry of Education, Science and Culture, Japan (Grant-in-Aid for Overseas Research No. 04041012).

References

ADAMS, C.J. and WHITLA, P.F. (1991): Precambrian ancestry of the Asgaard Formation (Skelton Group): Rb-Sr age of basement metamorphic rocks in the Dry Valley region, Antarctica. Geological Evolution of Antarctica, ed. by M.R.A. THOMSON *et al.* Cambridge, Cambridge University Press, 129-135.

ALLIBONE, A.H. (1992): Low pressure/high temperature metamorphism of Koettlitz Group schists in the Taylor Valley and Ferrar Glacier area, South Victoria Land, Antarctica. N. Z. J. Geol. Geophys., **35**, 115-127.

ALLIBONE, A.H., COX, S.C., GRAHAM, I.J., SMILLIE, R.W., JOHNSTONE, R.D., ELLERY, S.G. and PALMER, K. (1993a): Granitoids of the Dry Valleys region, southern Victoria Land, Antarctica: Plutons, filed relations and isotopic dating. N. Z. J. Geol. Geophys., **36**, 281-297.

ALLIBONE, A.H., COX, S.C. and SMILLIE, R.W. (1993b): Granitoids of the Dry Valleys region, southern Victoria Land, Antarctica: Geochemistry and evolution along the early Paleozoic Antarctic Craton margin. N. Z. J. Geol. Geophys., **36**, 299-316.

ANGINO, E.E., TURNER, M.D. and ZELLER, E.J. (1962): Reconnaissance geology of the lower Taylor valley, Victoria Land, Antarctica. Geol. Soc. Am. Bull., **73**, 1553-1562.

BARRETT, P.J., ELLIOT, D.H. and LINDSAY, J.F. (1986): The Beacon Supergroup (Devonian-Triassic) and Ferrar Group (Jurassic) in the Beardmore Glacier area, Antarctica. Geology of the Central Transantarctic Mountains, ed. by M.D. TURNER and J.F. SPLETTSTOESSER. Washington, D.C., Am. Geophys. Union, 339-428 (Antarct. Res. Ser., Vol. 36).

COX, S.C. (1993): Inter-related putonism and deformation in South Victoria Land, Antarctica. Geol. Mag., **130**, 1-14.

COX, S.C. and ALLIBONE, A.H. (1991): Petrogenesis of granitoid orthogneisses from the Dry Valleys region, south Victoria Land, Antarctica. Antarct. Sci., **3**, 405-417.

CRAW, D. and FINDLAY, R.H. (1984): Hydrothermal alteration of lower Ordovician granitoids and Devonian Beacon Sandstone at Taylor Glacier, McMurdo Sound, Antarctica. N. Z. J. Geol. Geophys., **27**, 465-475.

CRAW, D., MORRISON, A.D. and WALCOTT, C.R. (1992): Fluid inclusion evidence for widespread shallow hydrothermal activity in South Victoria Land, Antarctica. N. Z. J. Geol. Geophys., **35**, 21-28.

ELLERY, S.G. (1989): Lower Wright Geology. Unpublished M. Sc. thesis, lodged in the Library, University of Otago, New Zealand.

FAURE, G.M. (1986): Principles of Isotope Geology. New York, J. Wiley, 589 p.

FAURE, G.M. and JONES, L.M. (1974): Isotopic composition of strontium and geologic history of the basement rocks of Wright valley, southern Victoria Land, Antarctica. N. Z. J. Geol. Geophys., **17**, 611-627.

FINDLAY, R.H., SKINNER, D.N.B. and CRAW, D. (1984): Lithostratigraphy and structure of the Koettlitz Group, McMurdo Sound, Antarctica. N. Z. J. Geol. Geophys., **27**, 513-536.

GLEADOW, A.J.W. and FITZGERALD, P.G. (1987): Uplift history and structure of the Transantarctic

Mountains: new evidence from fission track dating of basement apatites in the Dry Valleys area, South Victoria Land. Earth Planet. Sci. Lett., **82**, 1-14.

GLEADOW, A.J.W., MCKELVEY, B.C. and FERGUSON, K.U. (1984): Uplift history of the Transantarctic Mountains in the Dry Valleys area, Antarctica, from apatite fission track ages. N. Z. J. Geol. Geophys., **27**, 457-464.

GRINDLEY, G.W. and WARREN, G. (1964): Stratigraphic nomenclature and correlation in the western Ross Sea region. Antarctic Geology, ed. by R.J. ADIE. Amsterdam, North-Holland, 314-333.

GUNN, B.M. and WARREN, G. (1962): Geology of Victoria Land between the Mawson and Mulock Glaciers, Antarctica. N. Z. Geol. Surv. Bull., **71**, 157 p.

JONES, L.M. and FAURE, G. (1967): Age of the Vanda porphyry dikes in the Wright Valley, southern Victoria Land, Antarctica. Earth Planet. Sci. Lett., **3**, 321-324.

KYLE, P.R., ELLIOT, D.H. and SUTTER, J.F. (1981): Jurassic Ferrar Supergroup tholeiites from the Transantarctic Mountains and their relationship to the initial fragmentation of Gondwana. Gondwana Five, ed. by M.M. CRESWELL and P. VELLA. Rotterdam, A. A. Balkema, 283-287.

MCDOUGALL, I. and GHENT, E.D. (1970): Potassium-argon dates on minerals from the Mt. Falconer area, lower Taylor Valley, South Victoria Land, Antarctica. N. Z. J. Geol. Geophys., **13**, 1026-1029.

STEIGER, E.H. and JÄGER, E (1977): Subcommission on geochronology; Convention on the decay constraints in geo- and cosmochronology. Earth Planet. Sci. Lett., **36**, 359-362.

STUVIER, M. and BRAZIUNAS, T.F. (1985): Compilation of isotopic dates from Antarctica. Radiocarbon, **27**(2A), 117-304.

(Received April 25, 1995; Revised manuscript received June 30, 1995)